



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE/NOAA FISHERIES

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CRUISE REPORT¹

VESSEL: *Townsend Cromwell*, Cruise 02-07 (TC-281)

CRUISE PERIOD: September 8 - October 7, 2002

AREA OF OPERATION: Northwestern Hawaiian Islands (NWHI) (Fig. 1)

ITINERARY:

- 8 Sept Embarked Russell Brainard, Edward DeMartini, Stephani Holzwarth, Jean Kenyon, Robert Schroeder, Brian Zgliczynski, Steve Cotton, Joseph Chojnacki, Jon Winsley, Peter Vroom, Scott Godwin, and Kimberly Page. Departed Snug Harbor at 1100 en route to NWHI.
- 9 Sept At 0700, the *Townsend Cromwell* diverted from its cruise track to assist the U.S. Coast Guard (USCG) Rescue Coordination Center in searching for an apparent distress signal from EPIRB. At 1215, the *Townsend Cromwell* received word from the USCG that the distress signal was a false alarm. *Townsend Cromwell* resumed transit to Necker Island. Conducted Dive Safety Management Drill for all divers and coxswains. Deployed Surface Velocity Program (SVP) satellite-tracked drifter (Argos ID# 30147) off Nihoa Island in 60 m of water at lat. 23°05.157'N, long. 161°58.486'W with two archival fish pop-up tags, A258 and 02P0189.
- 10 Sept Arrived at Necker Island at 1430 to commence operations. Conducted one fish and benthic rapid ecological assessment (REA) station along the south shore of Necker Island. Deployed Ocean Data Platform (acoustic Doppler current profiler and conductivity-temperature-depth recorder) in 25 m of water at lat. 23°34.080'N, long. 164°42.738'W at 1555 HST. Deployed a sea surface temperature buoy (SOSI #268-011, Argos ID# 28830) in 15.5 m of water at lat. 23°34.291'N, long. 164°41.865'W at 1640 HST. Conducted TOAD towed camera and of QTC acoustic habitat mapping operations (7.4 km). Deployed SVP satellite tracked drifter (Argos ID# 30288) in 34 m of water at lat. 23°33.94'N, long. 164°49.09'W. Departed for French Frigate Shoals (FFS).



¹ PIFSC Cruise Report CR-05-012
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- 11 Sept Arrived FFS. Conducted two fish and three benthic REA surveys at the northern portion of FFS near Shark Island. Conducted fish collection dive to collect specimens of *Dascyllus* sp. Retrieved Coral Reef Early Warning System (CREWS) oceanographic buoy (SOSI 261-001, Argos ID# 27267) deployed in September 2001 and deployed replacement buoy (SOSI 279-001, Argos ID# 21392) at same site, lat. 23°51.407'N, long. 166°16.310'W in 8 m of water. Deployed SBE39 subsurface temperature recorder (#00905) in 2 m of water in patch reef of lagoon pools at lat. 23°51.967'N, long. 166°13.180'W. Conducted towed-diver habitat/fish survey in backreef lagoon pools. Conducted tethered optical assessment device (TOAD) towed camera and 161 km of QTC acoustic seabed classification surveys over the western portion of FFS.
- 12 Sept Conducted three fish and benthic REA surveys and five towed-diver habitat/fish surveys along the east and southeast forereef slopes of the windward barrier reef. Conducted TOAD towed camera surveys over the southeastern reef slope and 142 km of QTC acoustic seabed classification surveys around entire atoll perimeter. Conducted shipboard CTD to a depth of 500 m at permanent CTD station at the south end of FFS.
- 13 Sept Conducted three fish and benthic REA surveys and five towed-diver habitat/fish surveys along northeast and north forereef slopes of windward barrier reef. Departed FFS en route to Laysan Island. Conducted QTC acoustic seabed classification surveys over Brooks Bank (21.3 km) and St. Rogatien Bank (6.8 km).
- 14 Sept Conducted shipboard CTD to a depth of 500 m at permanent CTD station south of Gardner Pinnacles. Deployed SVP satellite tracked drifter (Argos ID #30114) with pop-up satellite fish tags PSAT A217 and Wildlife Computers 02P0187 in 3050 m of water at lat. 24°08.906'N, long. 167°41.159'W.
- 15 Sept Arrived and anchored at Laysan Island at 0945. Deployed SST buoy (SOSI #268-010, Argos ID# 28829) at lat. 25°46.374'N, long. 171°44.551'W in 2.5 m of water. Conducted four towed-diver habitat/fish surveys, three fish and benthic REA surveys, eight shallow water CTDs, and one TOAD camera survey around Laysan Island. Conducted QTC acoustic seabed classification surveys over Laysan Bank until sea conditions caused too much rolling for adequate data quality (54.1 km). Departed Laysan Island en route to Lisianski Island. Deployed SVP satellite tracked drifter (Argos ID# 30350 at lat. 25°44.265'N, long. 171°49.771'W in 40 m of water.
- 16 Sept Arrived at Lisianski Island/Neva Shoals at 1300. Deployed SST buoy (SOSI #268-008, Argos ID# 12195) at former CREWS buoy site at position 25°58.061'N, 173°54.965'W in 8 m of water. Conducted two towed-diver habitat/fish surveys of reefs on east side of Neva Shoals. Conducted two fish and benthic REA surveys along southeast side of Neva Shoals. Conducted QTC acoustic seabed classification surveys over Lisianski Bank (21.7 km) and Bank #8 (10.7 km) en route to Pearl and Hermes Atoll. Deployed SVP satellite

tracked drifter (Argos ID# 30225) with pop-up satellite tags PSAT A252 and Wildlife Computers 01P0289 at lat. 26°18.216'N, long. 174°32.247'W in 63 m of water over Bank #8.

- 17 Sept Arrived at Pearl and Hermes Atoll at 1145. Retrieved CREWS buoy (SOSI 262-004, Argos ID #26105) and settlement/recruitment plates. Deployed three invertebrates traps. Deployed replacement CREWS buoy (SOSI 280-003, Argos ID #21376) at temporary site for the night. Conducted two fish and benthic REA surveys on southeast forereef slope. Conducted 11 shallow water CTDs along entire east side of atoll. Conducted TOAD drift dive along southeast reef slope. Conducted QTC acoustic seabed classification surveys along east side of atoll (5.7 km). Conducted two shipboard CTDs to a depth of 500 m.
- 18 Sept Completed deployment of CREWS buoy (SOSI 280-003, Argos ID #21376) at original site, lat. 27°51.245'N, long. 175°48.954'W. Retrieved invertebrate traps. Conducted two towed-diver habitat/fish surveys in the coral maze in the central lagoon and two surveys along the northern backreef just inside the barrier. Conducted three fish and benthic REA surveys along the northeast and north forereef slopes. Conducted 13 shallow water CTDs along northwest side and interior of atoll. Conducted TOAD drift dive over northwest reef slope. Conducted QTC acoustic seabed classification surveys along northwest reef slope (3.7 km). Conducted two shipboard CTDs to a depth of 500 m on northeast and northwest sides of Pearl and Hermes Atoll.
- 19 Sept Conducted five towed-diver habitat/fish surveys along south and southwest back reef and shallow forereef slope and southeast backreef. Conducted three fish and benthic REAs in lagoon. Conducted seven shallow water CTDs to complete survey around entire atoll. Conducted TOAD drift dive along reef slope south of anchorage area on south side of atoll. Conducted QTC acoustic seabed classification surveys along southern reef slope (9.0 km). Departed Pearl and Hermes Atoll en route to Midway Atoll.
- 20 Sept Deployed SVP satellite tracked drifter (Argos ID# 30291) to the west of Pearl and Hermes Atoll at position 27°51.347'N, 176°21.191'W. Arrived Midway Atoll at 0730. Retrieved Midway CREWS buoy and settlement/ recruitment plates. Deployed SST buoy (SOSI #268-009, Argos ID# 28831) at former CREWS buoy site at position 28°13.073'N, 177°20.641'W. Conducted four towed-diver habitat surveys along southeast, south, and southwest forereef slopes. Conducted five fish REA surveys and three benthic REA surveys in Welles Harbor.
- 21 Sept Conducted six towed-diver habitat/fish surveys along northeast, north, and northwest forereef slopes and northwest backreefs. Conducted three benthic and four fish REA surveys along northwest reef slope and backreef. Ship departed Midway Harbor. Conducted TOAD towed camera and QTC acoustic seabed classification surveys (18.9 km) around northwest side of Midway.

Conducted shipboard CTD to 500 m at permanent station. Departed Midway en route to Kure Atoll.

- 22 Sept Arrived Kure Atoll at 0730. Deployed replacement CREWS buoy (SOSI #280-002, Argos ID# 21531) at same site, lat. 28°25.118'N, long. 178°20.673'W. Conducted three fish and benthic REA surveys along southeast and south forereef slopes. Conducted two towed-diver habitat/fish surveys along the southeast and east forereef slopes. Deployed subsurface temperature recorder SBE#0903 at shipwreck on north end of lagoon at position 28°26.844'N, 178°18.365'W. Conducted 14 shallow water CTDs around atoll perimeter. Conducted TOAD towed camera dive along northwest side of Kure Atoll. Conducted QTC acoustic seabed classification surveys around western half of Kure reef slope (24.3 km). Conducted shipboard CTD to 500 m at permanent station.
- 23 Sept Deployed Ocean Data Platform (SOSI #267-005) on west side of Kure Atoll at position 28°25.782'N, 178°22.668'W. Conducted four towed-diver habitat/fish surveys of western back reef, eastern backreef, and coral gardens near CREWS buoy. Conducted five fish and three benthic REA dives along northwest backreef. Conducted 14 shallow water CTDs in lagoon. Conducted TOAD drift dive over southwest reef slope. Conducted QTC acoustic seabed classification surveys around atoll (130.7 km). Conducted shipboard CTD to a depth of 500 m.
- 24 Sept Conducted five towed-diver habitat/fish surveys along south and west reef slopes and northwest and north backreefs. Conducted four fish and benthic REA surveys in Kure Lagoon. Deployed subsurface temperature recorder (SBE39 #0907) at position 28°25.756'N, 178°22.105'W. Conducted TOAD drift dive along east reef slope. Conducted QTC acoustic seabed classification surveys around atoll (143.6 km). Departed Kure Atoll en route to Midway Atoll. Deployed SVP satellite tracked drifter (Argos ID# 29938) at position 28°25.187'N, 178°29.517'W.
- 25 Sept Arrived at Midway Atoll at 0700. Conducted five towed-diver habitat/fish surveys along west forereef slopes and southwest and north backreefs. Conducted four fish and benthic REA surveys of southwest forereef slope, two backreef sites, and the SST buoy location. Deployed subsurface temperature recorder (SBE39 #0904) in 1 m of water at position 28°16.664'N, 177°22.070'W. Conducted 17 shallow water CTDs around Midway Atoll. Conducted TOAD drift dive and QTC acoustic seabed classification surveys along northwest reef slope (58.4 km). Departed Midway Atoll en route to Pearl and Hermes Atoll.
- 26 Sept Arrived at Pearl and Hermes Atoll at 0700. Conducted five towed-diver habitat/fish surveys along northwest back reefs. Conducted four fish and three benthic REA surveys of northwest backreef. Deployed subsurface temperature recorder (SBE39 #0900) in 2.5 m of water at position 27°54.710'N, 175°53.657'W. Deployed subsurface temperature recorder (SBE39 #0906) in 1

m of water at position 27°57.450'N, 175°46.850'W in the middle of the Three Sisters Mokus. Conducted QTC acoustic seabed classification surveys along northwest reef slope (30.5 km). Conducted shipboard CTD to a depth of 500 m in southwest corner of Pearl and Hermes Atoll.

- 27 Sept Conducted five towed-diver habitat/fish surveys along northeast and east backreefs and in central lagoon coral maze near CREWS buoy site. Conducted three fish and one benthic REA surveys of northeast backreef and south lagoon. Anchored ship for the night.
- 28 Sept Embarked three media personnel from the *M/V Rapture* conducting interviews of scientists and crew to celebrate the last cruise of the *Townsend Cromwell*. Weighed anchor at 0630 to transit to the southwest corner of Pearl and Hermes Atoll. Conducted three towed-diver habitat/fish surveys along the southwest entrance channel and backreefs. Conducted two fish and benthic REA surveys of southwest backreef and lagoon. Deployed subsurface temperature recorder (SBE39 #0899) in 2 m of water at position 27°46.489'N, 175°58.720'W in 2 m of water on the right side of the small boat channel on the southwest side of the atoll. Disembarked media personnel. Departed Pearl and Hermes Atoll en route to Lisianski Island.
- 29 Sept Arrived at Lisianski Island at 0700. Conducted six towed-diver habitat/fish surveys around northeast, northwest outer reef slopes, east and northwest nearshore reefs and lagoonal waters on southwest side of island. Conducted three fish and benthic REA surveys of northeast, north and northwest sides of island. Deployed subsurface temperature recorder (SBE39 #0902) in 2 m of water at position 26°03.142'N, 173°58.091'W. Conducted TOAD towed camera dive over northwest bank. Conducted QTC acoustic seabed classification surveys along northwest and west banks (181.9 km).
- 30 Sept Redeployed subsurface temperature recorder (SBE39 #0902) to the east side of Lisianski Island in 0.5 m of water at position 26°03.801'N, 173°57.660'W. Conducted two towed-diver habitat/fish surveys of east side of Neva Shoals. Conducted two fish and benthic REA surveys of east side of Neva Shoals. Departed Lisianski Island/Neva Shoals at 1130 en route to Maro Reef.
- 01 Oct Conducted shipboard CTD to 500 m at Laysan Island permanent station. Arrived at Maro Reef at 0945. Deployed replacement CREWS buoy (#280-001, Argos ID# 21529) at former CREWS buoy site at position 25°26.791'N, 170°38.029'W in 8 m of water. Conducted two towed-diver habitat/fish surveys of deep pinnacle area on north side of Maro Reef. Conducted two fish and benthic REA surveys of southwest, west, and northwest reef spurs. Conducted TOAD towed camera dive and QTC acoustic seabed classification surveys over east bank of Maro Reef (230.2 km).
- 02 Oct Conducted four towed-diver habitat/fish surveys in deeper waters along the northeast, east, and southeast sides. Conducted three fish and benthic REA surveys on the northeast and east sides. Deployed subsurface temperature

recorder (SBE39 #00901) at position 25°23.050'N, 170°32.383'W in 1.5 m of water. Conducted 14 shallow water CTDs around perimeter of shallow reef habitats at Maro Reef. Conducted TOAD drift dive and QTC acoustic seabed classification surveys over northeast bank of Maro Reef (56.0 km). Departed Maro Reef at 2400 en route to FFS.

- 03 Oct Deployed SVP satellite tracked drifter (Argos ID# 30111) at position 25°04.402'N, 170°03.961'W in 2048 m of water. Conducted shipboard CTD to 500 m at permanent Maro Reef CTD site.
- 04 Oct Arrived at FFS at 0800. Refurbished mooring hardware on CREWS buoy (#279-001). Conducted four towed-diver habitat/fish surveys of reefs between Tern and Shark Islands, the northwest reef spurs near East Island and Round Island. Conducted three fish and benthic REA surveys of the northern interior portion of the open atoll. Deployed subsurface temperature recorder (SBE39 #00898) on the south side of La Perouse Pinnacle position 23°47.558'N, 166°14.009'W in 4 m of water. Conducted QTC acoustic seabed classification surveys over west bank of FFS (230.2 km). Departed FFS en route to Honolulu.
- 05 Oct Conducted shipboard CTD to 500 m at permanent station off Necker Island.
- 06 Oct Deployed SVP satellite-tracked drifter (Argos ID# 30311) at position 22°20.947'N, 161°14.248'W in 4800 m of water. Conducted post-cruise meeting on board to discuss cruise operations and identify potential areas for improvement.
- 07 Oct Arrived Snug Harbor, Pier 45, Honolulu, Hawaii to complete final research cruise of the *Townsend Cromwell* at 1300. Disembarked Brainard, DeMartini, Holzwarth, Kenyon, Zgliczynski, Schroeder, Vroom Godwin, Cotton, Page, Chojnacki, and Winsley.

MISSIONS AND RESULTS:

A. FISH SURVEYS

From 10 September to 4 October, the CREI Fish REA team (Edward DeMartini, Robert Schroeder, and Steve Cotton) conducted quantitative transects around eight islands/atolls of the NWHI according to NWHI Coral Reef Assessment and Monitoring Program (NOWRAMP) survey protocols. This included (with number of stations surveyed) various representative reef habitats around: Necker Island (1), French Frigate Shoals (FFS; 12), Lisianski-Neva Shoals (7), Laysan Island (3), Pearl and Hermes Atoll (17), Midway Atoll (12), Kure Atoll (12) and Maro Reef (5), for a total 69 stations. Some of these stations were surveyed in previous years, notably the historical stations established in 1980-1983 at Midway Atoll. The cumulative total of fish REA stations conducted by the Honolulu Laboratory in the NWHI during 2000-02 is 152. Surveys were conducted at depths of 1-15 m. Habitat types included fringing reef, outer barrier reef slope (forereef), inner reef flat (backreef), and lagoonal and oceanic patch reefs. Sea and swell conditions were generally

mild, with swells occasionally high (3 m); underwater visibility was generally moderate (10-20 m) but sometimes low (5-10 m) at FFS, Maro Reef, and Lisianski-Neva Shoals. The benthic team conducted coral and macroinvertebrate surveys within half-an-hour of the fish team at most stations. Water temperatures ranged from the high 26°C to 28°C.

As on the 2000 and 2001 NOWRAMP surveys, fish belt-transect stations consisted of three consecutive 25-m lines, separated by about 5 m, set along a single depth at 1.5-14 m. Each diver first tallied all fishes 20 cm total length (TL) within a 4-m wide strip (100 m² area) on the initial swim-out of each transect line. Each diver then tallied all fishes <20 cm TL within a 2-m wide strip (50-m² area) on the return swim of each line. Stationary Point Counts (SPCs) were conducted by a third diver recording species, with size class estimates, for all fish >25 cm TL within a 10-m radius at four points separated from the belt transect lines. REA surveys for additional species presence were conducted during the same dive following the quantitative surveys. Photos documenting fish and their habitat were taken at many stations.

The 2002 survey represents the third consecutive year that NOAA Fisheries, Honolulu Laboratory, has surveyed reef fish throughout the NWHI. Conclusions regarding the overall current status of NWHI fish assemblages must await pending statistical analyses. However, some initial impressions are worth mentioning. Findings were generally consistent with those of the 2 prior years. Coral reef fish assemblages in the NWHI appear to remain healthy and intact. Apex predators, dominated by large jacks (*Caranx* spp.) continue to be abundant in absolute terms (and relative to the MHI) at all sites surveyed, with the possible exception of Midway Atoll. Standing stocks of lower trophic level carnivores and herbivores remain high and of large average individual body size. These observations were not unexpected; shallow (<20 m) reefs of the NWHI remain de facto refuges because of their remoteness and are now officially protected from fishing within the NWHI Coral Reef Ecosystem Reserve. Labroids (wrasses and parrotfishes) such as the Hawaiian hogfish *Bodianus bilunulatus* and the spectacled parrotfish *Chlorurus perspicillatus* continue to exhibit smaller average body sizes at sex change from initial (female) to terminal (male) phases at Kure and Pearl and Hermes Atolls where apex predatory jacks appear to be more abundant (relative to Midway Atoll). Recruitment of 2002 year-classes was generally strong, perhaps better than observed in 2000 and 2001, which were also healthy. As in 2001, epidermal lesions (of unknown cause) were noted on a small percentage of goldring surgeonfish *Ctenochaetus strigosus* at FFS and Lisianski-Neva Shoals; the incidence of lesions had been much higher and geographically widespread in 2000. Marine debris is still being encountered occasionally, most commonly on the backreef at Midway Atoll and on reefs within the lagoon at Pearl and Hermes Atoll.

There were a few exceptional observations, however. Two fish species (the finescale triggerfish *Balistes polylepis* and the goldrim surgeonfish *Acanthurus nigricans*) were newly observed in the NWHI by the Honolulu Laboratory Fish Team. Whitetip reef sharks were consistently encountered, but grey reef and Galapagos sharks were seen less frequently this year than on previous NWHI assessments. The observed coral bleaching at the northern end of the archipelago has had no obvious effect on overall reef fish standing stock biomass or herbivore-to-carnivore ratios. However, several species of corallivorous fishes (the blue-eye damselfish *Plectroglyphidodon johnstonianus* and the leopard blenny *Exallias brevis*) appeared less and more abundant (or conspicuous), respectively, than on

previous surveys at the three northernmost atolls affected by the summer 2002 bleaching event. Definitive statements regarding corallivore densities remain pending statistical data analyses.

B. CORAL SURVEYS

Jean Kenyon, CREI marine ecologist, conducted coral surveys in conjunction with survey activities undertaken by other members of the benthic team (Peter Vroom, phycologist; Kim Page, phycological assistant; Scott Godwin, invertebrate biologist) and the CREI fish team (above). In accordance with Northwestern Hawaiian Islands Research and Monitoring Program (NOWRAMP) 2002 protocols agreed upon by coral scientists onboard the *Townsend Cromwell* and the collaborative charter vessel *Rapture*, video documentation of the benthic habitat as well as quantitative assessments of corals occurring within 2, 25-m-long transect lines were conducted around eight islands/atolls of the NWHI. This included (with number of stations surveyed) various representative reef habitats around: Necker Island (1), French Frigate Shoals (FFS; 11), Lisianski-Neva Shoals (7), Laysan Island (3), Pearl and Hermes Atoll (14), Midway Atoll (9), Kure Atoll (9) and Maro Reef (5), for a total 59 stations. Exclusive of coral REAs conducted by *Rapture* scientists in 2002 [the number of which remains to be reported as of this writing], the cumulative total of coral REA stations surveyed by Jim Maragos and Jean Kenyon working from the *Townsend Cromwell* and *Rapture* in the NWHI during 2000-02 is 155. Surveys in 2002 were conducted at depths of 0.5-14 m. Habitat types included fringing reef, outer barrier reef slope (forereef), inner reef flat (backreef), and lagoonal and oceanic patch reefs. Sea and swell conditions were generally mild, with swells occasionally high (3 m); underwater visibility was generally moderate (15-20 m) but sometimes low (5-10 m) at FFS, Maro Reef, and Lisianski-Neva Shoals. Water temperatures ranged from 26°C to 28°C. Although most benthic REA stations were surveyed by both the benthic team and fish team, a few sites were surveyed only by the benthic team; conversely, a few sites were surveyed only by the fish team.

Previous coral REAs in 2000 and 2001 were largely qualitative in nature, focusing on compiling species lists for the various islands and atolls of the NWHI as well as making subjective assessments of the relative abundance of each species at each site using the DACOR system (D = Dominant, A = Abundant, C = Common, O = Occasional, R = Rare). Surveys in 2002 were designed to be more quantitative in nature, and to include dedicated observations regarding coral bleaching and disease. Coral surveys in 2002 began by videotaping along the first 2 of 3, 25-m transect lines (each separated by about 5 m and set along a single depth at 5-45 feet) laid out by the fish team some 20-25 minutes prior to the benthic team's water entry. The coral biologist attempted to swim about 1 m above the transect line while videotaping, and additionally recorded 360° views of the surrounding area at the beginning, middle, and end of the transects' overall length. Then, on the swim-back along the two consecutive 25-m lines, each coral colony whose center fell within a 1-m-wide strip on either side of the line was categorized as having a maximum diameter belonging to one of 7 size classes (0-5 cm, 5-10 cm, 10-20 cm, 20-40 cm, 40-80 cm, 80-160 cm, or >160 cm). For species in which clonal propagation (e.g., *Porites compressa*) or fissioning (e.g., *Porites lobata*) is an important part of the life history strategy, judgments had to be made regarding the boundaries of individual colonies in order to assess the number of colonies present and their maximum diameter. In making such judgments, consideration was given to tissue color, interfaces with neighboring colonies of the same

species, and variations in growth form. When determinations of individual colonies could not be made on these criteria alone, conspecific areas of live tissue separated by more than 10 cm were considered to be separate colonies. In this manner, a total of 100 m² was surveyed at most sites; at two sites, strong current or an unusually large number of small colonies only allowed a portion of one transect line to be surveyed within the allotted dive time.

During the videotaping and subsequent swim-back/quantitative survey, assessments were made regarding the incidence and severity of bleaching as well as of disease or other tissue anomalies. Depending on remaining dive time and coordination with other members of the benthic team, the precision of bleaching assessments ranged from estimates of the percentage of the surface area of each species impacted by bleaching within the range of visibility and the degree of severity (i.e., the estimated percentage decrease in loss of normal pigmentation) to direct counts of bleached colonies within the transect belt. Observations included whether bleaching was accompanied by tissue mortality or if bleached tissue was still alive, as assessed by whether polyps in bleached tissue were visible and, if so, reacted to touch by retracting into their calices. Observations were also recorded for each station regarding species for which bleached tissue was not observed. At two sites, the central “coral gardens” at Kure (site TC-18-shallow) and a northern lagoon backreef at Midway (TC-20), additional digital videos were taken while randomly swimming, for several minutes, about the site to record the general nature and extent of bleaching. At most sites where bleaching was evident, digital still photos of the habitat and representative affected colonies were also taken.

Following the surveys conducted along the transect lines, a larger area at the site was examined to search for additional species of corals that did not fall within the belt transect and to make a subjective assessment, using the DACOR system, of the relative abundance of all coral species observed at the site. At most sites, digital still photos were taken of the general habitat and of selected corals. Digital still photos were taken of two corals that could not be identified in the field, one an unknown zoanthid and the other an unknown faviid.

The 2002 survey represents the third consecutive year that NOAA Fisheries, Honolulu Laboratory, in collaboration with its partners (most notably U.S. Fish and Wildlife Service) has surveyed corals throughout the NWHI. Conclusions regarding the overall current status of coral assemblages must wait pending further analyses. However, some salient observations can be stated even in the absence of more detailed analysis of written or videographic records.

For the first time, widespread, severe bleaching was observed and recorded in the Hawaiian Islands. The first observations of bleaching during coral REAs were made on September 17 at Pearl and Hermes Atoll (site TC-16, east outer barrier), at which an estimated 2% of the pocilloporids within the range of visibility were noticeably bleached. Observations conducted throughout the following 11 days in a variety of habitats at Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll revealed bleaching to have heavily impacted the coral populations of several species at all three atolls. A relatively low level of bleaching, as assessed by the number of colonies affected, was evidenced at sites along the outer barrier forereef at all three atolls. Given the low percentage of coral coverage

along these outer barrier forereefs, as well as the lack of coral species diversity (as revealed by both coral REAs and analysis of towboard surveys in 2000), the observation that bleaching was primarily witnessed in pocilloporids might well have been confounded with crown-of-thorns predation, as well as obscured the greater diversity of genera that were bleached and/or in the process of bleaching elsewhere within the atolls. Bleaching was most pronounced with the lagoon system of each atoll, at both patch reef habitats and, most markedly, at shallow backreef habitats. Written data from a 100-m² belt transect conducted at a north lagoon backreef REA site at Pearl and Hermes Atoll (site TC-26) exemplifies the nature of the phenomenon observed at virtually every backreef site visited at the three northern atolls: Of 40 colonies of *Montipora capitata* colonies counted, an estimated 50-80% of the surface area of all colonies were bleached, accompanied by gross tissue mortality; of 46 *Montipora turgescens* colonies counted, 27 were bleached such that pigmentation intensity was reduced an estimated 50-80%; of 17 *Pocillopora damicornis* and *P. meandrina* colonies counted, all 17 were completely bleached and dead; of 12 *Leptastrea purpurea* colonies counted, all 12 were bleached such that pigmentation intensity was reduced an estimated 80%. In contrast, colonies of *Pavona duerdeni* and *Fungia scutaria*, though rare at the site, did not appear to be bleached.

Differences in the incidence (i.e., counted number or estimated percentage) and severity (i.e., degree of loss of pigmentation and bleached tissue mortality/vitality) of bleaching among genera and species quickly emerged with continued observations. Members of the genus *Pocillopora*, along with the species *Montipora capitata*, were the most impacted by bleaching, both in terms of percentage of total individuals affected (incidence) and the degree to which bleaching had resulted in mortality of all or part of the colony (severity). Pocilloporids occur as discrete colonies that rarely exceed 50 cm in diameter in the NWHI; the majority of bleached pocilloporids were entirely dead, and the subsequent process of algal overgrowth was already in progress at many sites. In contrast, many montiporids, including *Montipora capitata*, form large colonies measuring more than 80 cm in diameter in backreef habitats; the boundaries of individual colonies can be difficult to determine as they spread through clonal propagation. Nearly all such large colonies had extensive areas of bleached, dead tissue, along with smaller patches of still-living tissue that showed a range of partial bleaching of pigments. The initiation of algal growth could be observed on the dead portions of such colonies. Whether the remnant patches of living tissue can maintain their vitality, extend growth onto portions of the bleached skeleton, or succumb to algal overgrowth remains to be observed in future monitoring efforts. *Montipora turgescens*, the second most prevalent montiporid at lagoon backreef sites, showed the next greatest incidence and severity of bleaching. Though most colonies observed at backreef sites at the three northern atolls showed partial fading of the populations' usual vivid blue coloration, the tissue was still alive and might potentially recover if not subjected to further stress.

Several species in the genus *Porites* (*P. lobata*, *P. evermanni*, and *P. compressa*) typically account for a large percentage of the overall live coral cover in a variety of habitats, including the outer barrier forereef and lagoon patch reefs, and are also well represented in the backreef habitat. At the three northern atolls, *Porites* colonies, although occasionally observed to contain patches of partially bleached, living tissue, were less impacted by the bleaching phenomenon, particularly when considered in relation to their numerical abundance and substantial contribution to overall coral cover. Written data from a 100-m²

belt transect conducted at a shallow (2-m depth) site within a central area of lagoon patch reefs at Kure atoll (“coral gardens,” site #TC18-shallow) exemplifies this disparity in the degree to which resident genera were affected: Of 151 pocilloporids counted within the belt transect, all were 100% bleached, dead, and partially overgrown with turf algae; of 15 colonies of *Montipora turgescens*, all were bleached white and dead; of 44 colonies of *Porites lobata* within the belt transect, none appeared bleached or otherwise anomalous in colony surface appearance. Moreover, *Porites compressa*, a species that readily spreads through asexual, clonal reproduction and whose colony boundaries can be difficult, if not impossible, to detect in the field, was the dominant species at the site; nonetheless, only an estimated 5 to 10% of the surface area was bleached, though not to any degree that resulted in tissue mortality. Other coral species that occasionally occurred in the high-bleaching-risk areas of the patch reefs and backreefs at the three northern atolls were only rarely observed to show a low level of bleaching, which was not accompanied by tissue mortality. These species include *Pavona duerdeni*, *Pavona varians*, *Cyphastrea ocellina*, *Fungia scutaria*, and *Psammacora stellata*. These species, however, typically form only small colonies that contribute but a very small percentage of overall coral cover.

In light of this hierarchy of coral susceptibility to bleaching at the three northern atolls, it is interesting to note a divergence from this ranking at both Lisianki-Neva Shoals and Maro Reef, both of which (with the exception of two dives at Lisianki-Neva Shoals) were surveyed after the three northern atolls. At both of these reef complexes, the incidence and severity of bleaching were considerably less than at the three northern atolls. Moreover, at these reef complexes, in both of which the pocilloporids, montiporids, and *Porites* comprise an estimated 90% of the coral cover, members of the genus *Porites* were relatively more impacted than were the pocilloporids and montiporids. Written data from a site north of Lisianski Island (TC-11) surveyed on 29 September exemplify this generalization: Of 120 colonies of *Montipora tuberculosa* and *M. turgescens* counted within the belt transect, an estimated 15% of the colonies had partially bleached tissue unaccompanied by tissue mortality, whereas a counted 5 (20%) of the 25 *Porites* colonies had partially bleached tissue unaccompanied by tissue mortality. This trend towards heightened susceptibility of *Porites* relative to other genera was further manifested at Maro Reef where the few corals observed with bleaching stress were almost invariably members of the genus *Porites*, even though montiporids and pocilloporids were well represented at Maro Reef. Members of the genus *Acropora*, which are typically among the first species to suffer bleaching in other regions where they are important members of the coral assemblage (e.g., western Pacific), were not observed to have experienced bleaching at either Maro Reef or French Frigate Shoals (where they are numerically most abundant in the NWHI), although dense populations of *Acropora valida* and *Acropora cytherea* were observed at Maro Reef and French Frigate Shoals, respectively (Maro site TC-28 and FFS sites TC-21 and TC-30).

At most sites where bleaching was observed, algal growth on the dead coral skeletons was also noted. The degree to which overgrowth had progressed was quite consistent within each site but demonstrated a range of variation among sites. It would be instructive, in terms of our understanding of reef dynamics on ecological time scales, to know how quickly the process of coral skeleton overgrowth by turf, fleshy, and coralline algae occurs, as such information could be useful in inferring past events from recent observations. For example, at two sites at Pearl and Hermes Atoll within two different habitats (site TC-17,

outer barrier, and site TC-30, SW backreef), there was a striking number of large, dead *Pocillopora* heads, all of which were coated with a similar assemblage and density of algae. At site TC-30, 124 dead *Pocillopora* colonies were counted within the 100-m² belt transect, 95% of which were larger than 20 cm in diameter, and all of which were heavily encrusted with a similar density and assemblage of turf, fleshy, and coralline algae. Only 26 live pocilloporids were counted within the belt transect, of which only 38% were larger than 20 cm in diameter. At TC-17, 76 dead *Pocillopora* colonies were counted within the 100-m² belt transect, all heavily encrusted with turf and coralline algae, whereas only 1 living *Pocillopora meandrina* colony was counted, which measured less than 5 cm in diameter. At both sites, the abundance of large, dead coral *Pocillopora* heads with similar levels of algal encrustation, coupled with the relative paucity of living pocilloporids largely representing small size classes, suggests that some event led to the death of the larger, older colonies within a narrow window of time. Judging from sea surface temperature data telemetered from CREWS buoys at Pearl and Hermes, Midway, and Kure Atolls (Rusty Brainard, pers. comm.), coupled with anecdotal observations by CREI Marine Debris Specialists working at Pearl and Hermes Atoll in July 2002 (Joe Chojnacki, Kim Page), the present bleaching event appears to have developed to its present state within a period of less than 3 months. It is hypothesized, based upon the observations summarized above, that bleaching episodes have occurred in the northern atolls of the NWHI in the recent past as well, resulting in concentrated, species-specific mortality, the species range of which is determined by the intensity and duration of physical factors implicated in causing bleaching (e.g., heightened sea surface temperatures coupled with periods of intense UV radiation). Future observations of the ecological fate of recently bleached reefs will be instructive in better understanding both the short-term and longer-term dynamics that have sculpted, and continue to sculpt, these reefs.

C. ALGAL SURVEYS

Algae are among the fastest growing organisms in coral reef ecosystems, and changes in algal species composition and abundance can serve as early warning indicators of change in the overall reef environment. Increases or decreases of algal abundance on marine reefs do not necessarily indicate the declining health of the ecosystem; however, they inform scientists of potential problems that may need to be monitored. For instance, increases in algal abundance may be the result of overfishing, sewage contaminants, or coral bleaching. Decreases in algal abundance may be the result of increased herbivore populations.

The Northwestern Hawaiian Islands contain some of the most pristine coral reef ecosystems in the world. Because of their isolation and the relatively few human activities in the area, algal species composition and abundance on Northwestern Hawaiian reefs are natural (i.e., no alien species are known, and pollution is not a factor affecting abundance). This gives scientists the opportunity to monitor fluctuations and population dynamics in algal communities without the confounding effects present in many other reef systems around the world.

Previous expeditions from the Coral Reef Ecosystem Investigation (CREI) have brought back copious amounts of algal material that are currently being examined. Close to 150 species have been reported from the Northwestern Hawaiian Islands so far, and more species are being found as samples are processed. The majority of these species are turf algae (small plants less than 1 cm tall that grow in dense, often multispecies, mats) and

epiphytes (tiny plants that grow on larger plants). Although the diversity of these small organisms is of great importance to the ecosystem as a whole, the plants themselves are too small to monitor in field settings, and identification of species is extremely time intensive. In order to quickly monitor and assess change in algal species composition and abundance in the field, macroalgae (plants large enough to be noticed and recognized by divers) are the organisms that have to be assessed.

Starting in September 2002, the CREI program has started monitoring the types of macroalgae present in the Northwestern Hawaiian Islands and their percent cover in various reef settings. Photoquadrats taken along fish transect lines tie algal population structure to fish communities in the same area and provide permanent historical records where percent cover can be objectively analyzed with various computer software packages. Algal samples taken from the photoquadrats will allow scientists to identify species that occur in photographs at a microscopic level and allow for the creation of permanent herbarium records that may eventually be deposited at national research institutions.

When possible, turf algae (which grows on essentially every hard surface present in a reef community) were collected for future analysis. However, to expedite photoquadrat image processing, these genera will be lumped into the category “turf” during photoquadrat analysis. Additionally, epiphytes found growing on macroalgae will also be kept for future processing.

Abundance of macroalgae within photoquadrats was recorded as algae were collected in the field. A “1” was given to the most abundant alga, “2” to the next most common, etc. This set of data is useful when analyzing photoquadrats and gives a rough estimate of which algae are most common in the environment. However, it is important to realize that these numbers are subjective, and different recorders may view the abundance of algal genera within a single quadrat differently. Additionally, using this method, a quadrat that contains 100 individuals of *Halimeda* and 3 of *Microdictyon* will receive the exact same ranking as a quadrat that contains 30 plants of *Halimeda* and 29 of *Microdictyon*. Therefore, the data these numbers represent must be regarded with a wary eye. Finally, these numbers imply nothing about percent cover.

Future visits to the same reef regions in the Northwestern Hawaiian Islands over time will allow us to document natural fluctuations in algal diversity and percent cover. Once identification of macroalgal species is complete and percent cover determined through photoquadrat analysis, diversity indices will be used to determine the areas within and between islands that are most similar. This type of information will prove important for reef management schemes. For instance, if algal communities in specific areas in the Northwestern Hawaiian Islands begin to change dramatically, similar sites that group together when analyzed with diversity indices will alert reef managers of other sites that might be subject to similar change.

Summary Statistics:

Towed Diver Habitat/fish Surveys - 83

FFS - 15	Maro - 6
Laysan - 4	Lisianski/Neva - 10

Pearl & Hermes - 22 Midway - 15

Kure - 11

Fish Rapid Ecological Assessment Surveys - 68

Necker - 1 FFS - 11

Maro - 5 Laysan - 3

Lisianski/Neva - 7 Pearl & Hermes - 17

Midway - 13 Kure - 12

Benthic Rapid Ecological Assessment Surveys - 62

Necker - 1 FFS - 12

Maro - 5 Laysan - 3

Lisianski/Neva - 7 Pearl & Hermes - 14

Midway - 10 Kure - 10

CREWS buoy deployments - 4

FFS - 1 Maro - 1

Pearl & Hermes - 1 Kure - 1

Ocean Data Platform deployments - 2

Necker - 1 Kure - 1

SST buoy deployments - 4

Necker - 1 Laysan - 1

Lisianski/Neva - 1 Midway - 1

Subsurface Temperature Recorder deployments - 10

FFS - 2 Maro - 1

Lisianski - 1 Pearl & Hermes - 3

Midway - 1 Kure - 2

SVP satellite tracked drifter deployments - 10

Settlement/recruitment plate deployments - 10 arrays

Shipboard CTDs to 500 m - 13

Shallow water CTDs - 111

TOAD towed camera dives - 13

QTC acoustic habitat classification surveys - 1332 km

Shipboard ADCP/TSG transects - 4500 km

RECORDS:

The following forms, logs, charts, and data records were kept and given to the Honolulu Laboratory upon termination of the cruise. These include all data captured onto computer storage media during the cruise. All the records are filed there unless indicated otherwise in parentheses.

QTC acoustic seabed classification data

TOAD digital video tapes (VHS & MDV)

ArcView GIS track files and shape files

ADCP DOPPLER ping data files on CD-ROM*

CTD Station Data Log Sheet

Seabird CTD data files on CD-ROM*

Digital camera photos (JPG file format) on CD-ROM*

Marine Operations Log
 Project Area and Operations Chartlets
 Scientist's Log
 SCS data files (raw & compressed) on CD-ROM*
 Station Number and Activity Log

* All data files together on the same (1) CD-ROM

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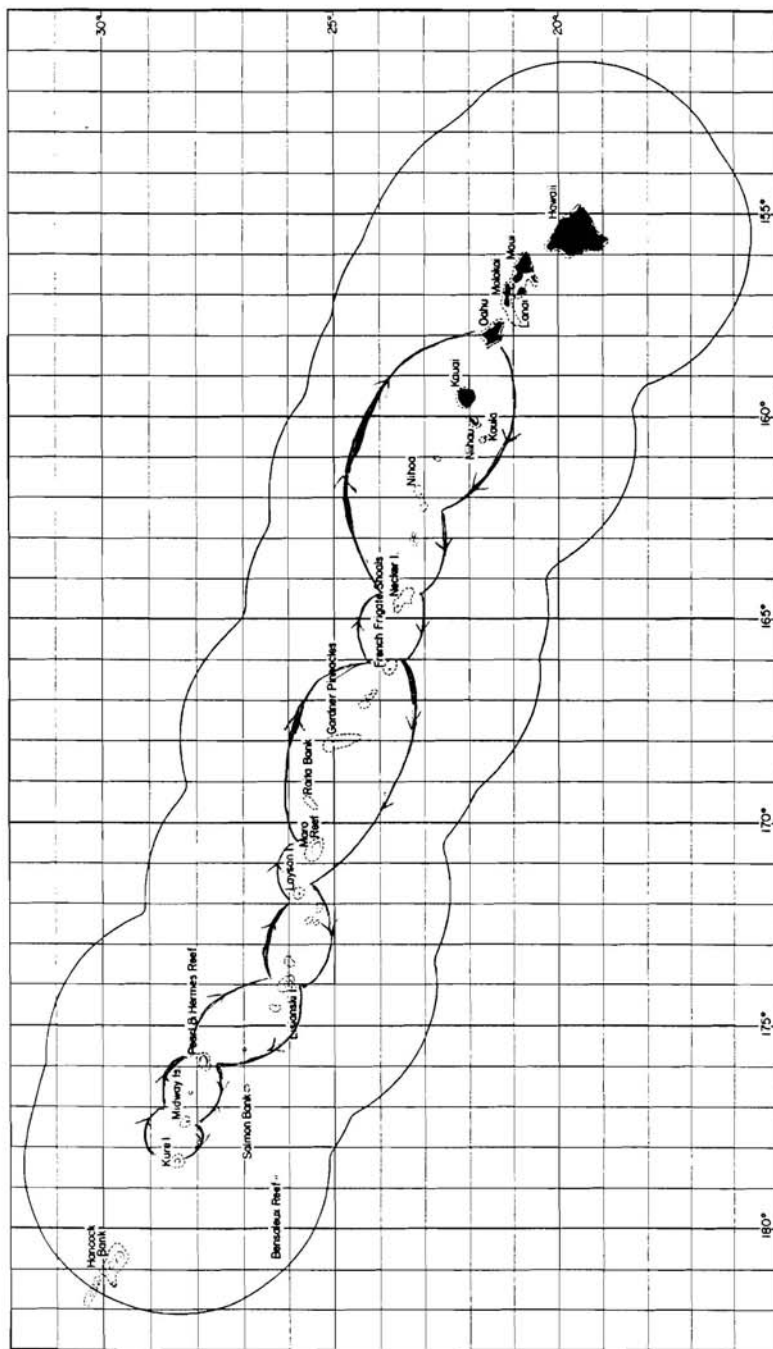


Figure 1.--Track of the NOAA ship Townsend Cromwell cruise TC-02-07 (TC-281), September 8 to October 7, 2002.